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Forensic approach to improving science teaching in high school

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Abstract

Forensic science can be defined as the application of sciences to legal matters. Nowadays, television series have increased the interest over forensic themes. This interest, associated with the recognized role of practices in the natural sciences, could probably be used to improve the teaching-learning process in high school and to discuss biology, physics, and chemistry. A hundred students in two high schools answered questions about their knowledge and the use of the forensic approach, with the aim of contextualizing practical science classes. As the students showed interest, six easily used forensic contextualized practical classes were proposed, focusing on interpretation and on the development of knowledge, skills, and competencies.

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1. Introduction

Forensic science can be defined as the application of sciences to legal matters, especially in criminal cases (Gialamas, 2000). Science history is full of theories and hypothesis consolidation that have happened due to forensic questions (Garrido & Giovanelli, 2009). As an example, about three centuries before Christ, the "Archimedes Principle" was established. In order to find out whether pieces of royal crown were false or not, he immersed pieces of gold and silver in water, whatallowed him to discover a fraud (Barbosa & Breitschaft, 2006).

Nowadays, movies and television series show a glamorous and exciting view of the forensic scientist. Certainly, this picture is different from that concerning about other scientists. This approach toward forensic sciences enhances the interest of the population in this area of knowledge (NSF, 2000). This interest can be used to stimulate the teaching and learning of the natural sciences at different educational levels (Garrido, 2010).

At the high school level there are interesting proposals, one of which is to use classical forensic experiments to teach and learn science (Filho & Antedomenico, 2010). Such a proposal aims to offer scholarly content under an interdisciplinary view. It is also intended to maintain a link between reality and curriculum, as suggested by the National Curricular Parameters in Brazil (Brasil, 2002).

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Moreover, making classes practical is considered essential for the teaching and learning of chemistry, physics, and biology. This would enable students to understand the processes and concepts of these sciences (Dillon, 2008). According to Andrade and Massabnin (2011), practical activities encourage the development of curiosity, respect for the diversity of opinions, persistence in the search for information, as well as loyalty to the truth of an investigative work. These concepts are demanded by the National Curricular Parameters.

This work intends to recognize interest in forensic science and its applicability in practical classes with subjects such as chemistry, physics, and biology. Toward this end, interviews were carried out with high school students from the private and public school systems in Rio de Janeiro. Efforts have been made to construct six easily used forensic contextualized assays for practical classes in the natural sciences.

2. Material and methods

The study was carried out in July 2012. A hundred students from three high school classes were interviewed. Two schools were selected: a private school, the Colégio Fernando Costa (65 students) in Seropédica, and a public school, the Colégio Estadual Madre Teresa de Calcutá (35 students) in Rio de Janeiro. The interviews involved six questions that looked into the way that natural sciences were presented to students. Whether they had practical classes was analyzed. The students' knowledge and their interest in a practical program to be included in curriculum and to be developed for chemistry, physics, and biology, and related to forensic science, were determined as well.

Six easily used forensic assays that could fit the schools' reality and limited resources were tested for practical classes. These assays were as follows:

1. Detection of milk adulteration with hydrogen peroxide by iodide oxidation (Rossi, 2010);
2. Detection of gasoline adulteration with ethanol (Dazzani et al., 2003);
3. Simulation of cocaine hydrochloride detection by potassium thiocyanate and cobalt chloride (Tsumura, Mitone & Kimoto, 2005);
4. Onion DNA extraction by salting out (Garrido, 2012);
5. Fingerprint revelation by $AgNO_3$ and Ninhydrin (Garrido, 2012);
6. Presumptive blood test by Kastle-Meyer reagent (Filho & Antedomenico, 2010);

These tests can be easily used in chemistry or biology courses. They allow advances in the concepts and processes explained by these sciences.

3. Results and discussion

The hundred students interviewed related the absence of practical teaching of the natural sciences. Unfortunately, this information was not surprising to the authors, once teachers in basic education seldom use practical resources, which happens because of structural difficulties. Above all, teachers think that practical classes would be laborious and would not be correctly understood by students, whose knowledge includes plenty of wrong concepts (Andrade & Massabnin, 2011).

It is true, however, that the quality of practical classes may improve learning (Dillon, 2008). The interviews revealed that 90 students watched programs about criminal investigation, and 94 thought classes would enhance the learning process. The students showed the desire to practice what they had learned, particularly if their classes presented themes related to forensics. For example, establishing scientific basis through the use of movies and journals may bring great benefits to the teaching-learning process (Filho & Antedomenico, 2010).

Interest in practical classes and the recognition of aids to learning are important, especially when these are analyzed in the same group: 50% (third year) to 75% (first year) of students interviewed in private schools and up to 30% (third year) in public schools said they had had no interest in any of the disciplines of the natural sciences. The analysis showed that interdisciplinarity and contextualization of content with forensic themes, besides benefiting learning, stimulate interest in science (Garrido, 2010).

With the importance of forensic science recognized, we tested a group of six experiments with interdisciplinary themes for forensic use under this educational reality (Table 1). The proposed experiments, which were based on the literature, proved to be easily adapted to the reality of these schools to promote the learning of subjects in the natural sciences, particularly chemistry and biology, through contextualization with forensic issues. The reagents used in the tests presented very low chemical risk when handled with good practices, and most are easily found under undergraduate laboratory standards, even for high school. Furthermore, the results of the tests are clearly seen using common glassware and do not need any equipment for analysis. The ease of use is essential to the reality of most Brazilian basic education teachers, and the lack of structural barriers addresses the non-realization of practical classes (Andrade & Massabnin, 2011).

Table 1. Some interdisciplinary themes in natural science contextualized by forensic practical classes

Practical Classes	Interdisciplinary Themes
Detection of milk adulteration with hydrogen peroxide by iodide oxidation	Microorganisms; Oxi-reduction; Inorganic catalysts;
Detection of gasoline adulteration with ethanol	Molecular polarity; Intermolecular interactions; Organic functions;
Simulation of cocaine hydrochloride detection by potassium thiocyanate and cobalt chloride	Vegetal metabolism; Organic functions; Acid-base reactions;
Onion DNA extraction by salting out	Vegetal cells; Biomolecules; Intermolecular interactions
Fingerprints revelation by $AgNO_3$ and Ninhydrin	Biomolecules; Mineral salts; Exocrine and apocrine
Presumptive blood test by Kastle-Meyer reagent	Blood tissue; Hemoglobin; Coordination compounds.

4. Conclusion

The study found that high school students had a great interest in improving learning through practical lessons, especially when these lessons are contextualized with updated issues, such as forensic science. Most of the students interviewed had already watched movies and television series related to the activities of the forensic scientist and would have liked to participate at practices that addressed the concepts and processes of physics, chemistry, and biology applied to this practice. This observation opens an important opportunity to bring students to the knowledge of the natural sciences in their curriculum, since they had indicated that these contents did not attract their interest.

Moreover, the possibility of developing practical classes for the easy implementation of experiments without the need for equipment and inaccessible reagents goes against some of the structural problems that appear to limit the use of practical lessons in the daily teaching of natural sciences in Brazilian basic education.

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